

**CLAIMS**

1. An water system comprising:  
a body of water; and  
5 a free radical generator comprising an inlet connectable to a substantially pure water source, a channel fluidly connected to the inlet, the channel disposed to flow the substantially pure water therethrough, an ultraviolet radiation emission source disposed to irradiate the substantially pure water and generate free radicals therein, and an outlet fluidly connected to the body of water.
- 10 2. The water system of claim 1, further comprising a hydroxyl donor inlet fluidly connected downstream of the inlet.
3. The water system of claim 1, wherein the ultraviolet radiation emission source  
15 can emit ultraviolet radiation with a wavelength of less than or equal to about 254 nm.
4. The water system of claim 1, wherein a surface of the channel is reflective to ultraviolet radiation.
- 20 5. The water system of claim 1, further comprising a coating on a surface of the channel, the coating capable of catalytically promoting free radical production of the substantially pure water upon irradiation of ultraviolet radiation.
6. The water system of claim 5, wherein the coating comprises titanium dioxide.
- 25 7. The water system of claim 1, wherein a wall of the channel comprises any of stainless steel, titanium or alloys thereof.
8. The water system of claim 1, wherein the ultraviolet radiation source comprises  
30 an ultraviolet an ultraviolet lamp separated from the substantially pure water by a ultraviolet radiation-transparent wall.
9. The water system of claim 8, wherein the wall comprises quartz.

10. The water system of claim 8, wherein the wall is disposed from the surface at a distance of less than about 100 mm.

5 11. The water system of claim 10, the wall is disposed from the surface at less than about 1 mm.

12. The water system of claim 11, the wall is disposed from the surface at less than about 0.1 mm.

10

13. The water system of claim 1, further comprising a nozzle disposed between the outlet and the body of water to accelerate mixing of the irradiated substantially pure water with the body of water.

15

14. A method of minimizing undesirable species in a water system comprising:  
providing substantially pure water to a free radical generator;  
irradiating the substantially pure water with ultraviolet radiation to produce a solution comprising free radicals; and  
adding the solution to the water system.

20

15. The method of claim 14, further comprising the step of adding a hydroxyl free radical donor to the substantially pure water.

16. The method of claim 15, wherein the hydroxyl free radical donor comprises at least one of hydrogen peroxide, ozone, oxygen and a peroxygen compound.

25

17. The method of claim 14, further comprising the step of minimizing the turbidity of the substantially pure water.

30

18. The method of claim 14, further comprising the step of lowering a pH of the substantially pure water to less than about 9.

19. The method of claim 14, wherein the ultraviolet radiation has a wavelength of less than or equal to about 254 nm.

20. The method of claim 14, further comprising the step of minimizing any hydroxyl free radical-consuming species in the substantially pure water.

21. The method of claim 14, wherein the substantially pure water is irradiated for about 1 to about 100 seconds.

22. The method of claim 14, wherein the liquid has a turbidity of less than about 100 NTU.

23. The method of claim 22, wherein the liquid has a turbidity of less than about 1 NTU.

24. The method of claim 14, wherein the solution has a strength of at least about 0.1 % as active  $H_2O_2$ .

25. The method of claim 24, wherein the solution has a strength of at least about 0.5 % as active  $H_2O_2$ .

26. A method of reducing oxygen demand in a water system comprising:  
providing a low oxygen demand liquid to a hydroxyl free radical generator;  
irradiating the low oxygen demand liquid with actinic radiation to generate  
hydroxyl free radicals in the liquid; and  
adding the hydroxyl free radicals to the water system.

27. The method of claim 26, wherein the low oxygen demand liquid is not water from the water system.

28. A method of facilitating treating a water facility comprising providing a reactor comprising a water inlet fluidly connectable to a substantially pure water source, a

channel fluidly connected to the inlet, the channel disposed to flow the substantially pure water therethrough, an ultraviolet radiation emission source disposed to irradiate the substantially pure water and generate hydroxyl free radicals therein and an outlet downstream of the ultraviolet radiation emission source, the outlet fluidly connectable to the water facility.

29. A method of operating a water system comprising:

providing a reactant solution consisting essentially of substantially pure water;  
irradiating the reactant solution with ultraviolet light to produce an oxidant

solution having free radical species; and

mixing the oxidant solution with water in the water system.

30. A water system comprising:

a reactant solution source providing reactant solution consisting essentially of  
water substantially free of free radical consuming contaminants; and

an ultraviolet radiation source fluidly connected to the reactant solution source  
and constructed and arranged to irradiate the reactant solution and fluidly connected to  
water in the water system.